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Research Article

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Available micronutrient status of sunflower growing soils of Nagpur district (Maharashtra)

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Summary

The present investigation was carried out to study the status of major micronutrients in sunflower growing soils of Nagpur district during the year 2009-2010. For this purpose in 6 profile 32 soil samples were collected from two tehsils (2 villages from each tehsil) of sunflower growing soils of Nagpur district. From each village soil sample was collected and subjected to laboratory for analyzing for some chemical properties and status of available micronutrients *viz.*, Zn, Fe, Mn and Cu. The correlation co-efficient between chemical properties and available nutrients were worked out. The study revealed that the soils are neutral to alkaline in reaction, safe in limit of electrical conductivity low to high in content of organic carbon and non-calcareous to calcareous in nature. The soil samples were deficient in available Zn, medium to sufficient in available Mn and sufficient in available Fe and Cu. The data showed that available Zn had significant negative relationship with pH (-0.125*) and $CaCO_3$ (-0.97*) and significant positive with EC (0.149**). Available Fe had significant and positive correlation with EC (0.135**) and O.C. (0.106*) and significant negative with $CaCO_3$ (-0.141*). Available Mn had negative and significant correlation with EC (-0.130**) while Cu had positive significant relation with EC (0.101*) and O.C. (0.170**).

Key words : : Available Zn, Fe, Mn, Cu, Soil

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Introduction

An increase in population pressure increased the demand of edible oil greatly in last decade. As a result there is an increase in the area of oil seed crops in the country. Among the oil seed crops, sunflower (*Helianthus annuus* L.) is largely popularized in recent years in the country as well as in Maharashtra. It is also an important oil producing crop in temperate countries and largest source of vegetable oil in the world, next to soybean, cotton and rapeseed. Sunflower contributes 8 per cent towards edible oil production in country behind soybean 21 per cent, groundnut 14 per cent, rapeseed, mustard 13 per cent (Hegde, 2005). The sunflower protein also consists of high percentage of amino acids which are essential in human nutrition.

In India, sunflower growing area is 2.16 m.ha (2010-11) with productivity of 567 kg ha^{-1}. In Maharashtra it is grown in 22 districts with an area of 361 thousand ha and productivity of 548 kg ha^{-1} (2010-2011), Vidarbha shares 6.24 per cent area of Maharashtra (Ekbote, 1992). In Nagpur district, the sunflower is raised in 2500 ha with productivity of 850

kg/ha (2006-2007). Most popular varieties of sunflower in Vidarbha are 'Surya' and 'Morden' with duration of 90-95 days, head diameter 15-20 cm, seed yielding ability of 800-1000 kg and oil content (30-35%).The other popular hybrid varieties grown in Vidarbha area are PKVSF-9, LSH -1 and LSH - 3 with comparable duration and head diameter but high seed yielding ability of 1000-1500 kg and oil yield capability of 38-40 per cent.

Sunflower being oilseed legume besides phosphorus and sulphur some of the micronutrients like Zn, Fe, Mn and Cu are required to improve and sustain performance of the sunflower crop. Zinc promotes growth hormones, starch formation, seed maturation and production of plant whereas, Iron helps in the absorption of other nutrient, Fe and Mn play an important role in chlorophyll formation and copper has some indirect effect on nodule formation.

However, there is a large decline in yield levels of the crop in recent years and farmers are shifting to another cropping pattern. Low soil fertility and inadequate manuring are the major causes for the low yield of the sunflower crop. In addition to this intensive cultivation of oilseed crops removed substantial amount of micronutrient from the soil, especially zinc, causing yield reductions. The analysis of soils indicated that Zn deficiency was the most serious constraint to sustainable productivity in 11 states of India (Takkar, 1996). In order to maintain high crop productivity, periodic application of zinc fertilizer is necessary, based on the soil test data.

Availability of micronutrients is influenced by several soil factors. Hence, establishing the relationship between various soil factors and micronutrients content of soils is of almost important. However, a very little or no information is available on the status of micronutrients in oilseed growing soils of Marathwada region of Maharashtra. Accordingly the present study was undertaken with a view to assess the micronutrients status in sunflower growing soils of Nagpur district.

Inspite of the favourable soil and agro-climatic conditions, the yield of sunflower in Vidarbha is far below as compared to that of Marathwada region of Maharashtra. The cause of low productivity has been investigated in shrink-swell soils (Pathe,1996). Increase in productivity will benefit the farmers in terms of monetary gain and use of good quality healthy oil. Despite favorable soils, agro-climatic conditions, and farmer's choice, the spread of sunflower and productivity as a whole in eastern Vidarbha is lower as compared to that of neighboring states namely Andhra Pradesh and Karnataka and even Marathwada region of Maharashtra.

Resource and Research Methods

Collection of soil samples :

In order to study the chemical properties and assess the status of available Zn, Fe, Mn and Cu in soil from Nagpur district, thirty two soil samples were collected from two tahsil (Umred and Bhiwapur) of Nagpur district where sunflower crop is being grown since last 3-4 years as a component of dominant cropping system in the district.

The soil pH was determined in soil: water suspension (1:2.5) using glass electrode pH meter (Jackson, 1973). Free calcium carbonate was determined with rapid titration method by Piper (1966). Modified method of Walkley and Black (1934) (Jackson, 1973) was used for determination of organic carbon. Micronutrient cations *viz*., Fe, Mn, Zn and Cu in soil were determined as per the procedure described by Lindsay and Narvell (1978). For this 10 g finely sieved soil (0.5mm) was shaken in 20 ml of 0.05 M DTPA solution (Diethylenetriaminepenta acetic acid containing 0.1M triethanol amine and 0.01 M calcium chloride, adjusted to pH 7.3 with HCl) for two hours and filtrated through Whatman no. 42 filter paper and clear filtrate was collected. The filtrate was used for measurement of Fe, Zn, Mn and Cu using atomic absorption spectrophotometer (AAS-200), at different wavelength for Fe, Zn, Mn and Cu. The correlations of chemical characteristics with available nutrients were worked out as per standard method given by Panse and Sukhatme (1967).

Research Findings and Discussion

The data presented in Table 1 shows that the pH of the sunflower growing soils of Nagpur district ranged from 7.93 to 8.64 with an average value of 8.39. These soils were neutral to alkaline in reaction. The relative high value of pH of these soils might be due to high degree of base saturation (Mali and Raut, 2001). The EC values of these soils were in safe range from 0.19 to 0.67 dSm^{-1} with an average value of 0.28 dSm^{-1}. The low EC value was observed in these soils may be due to leaching of salts from surface layer soils, as Nagpur district received precipitation 648.5 mm during the year 2009, these results are in conformity with Dwivedi *et al*. (2005).

The organic carbon content ranged from 0.24 to 0.79 per cent with an average value of 0.51 per cent. The variation in the organic carbon content of soil may be attributed to the factor like high temperature of Nagpur district (44.3^{0}C) which was responsible to hasten the rate of oxidation as well as very little amount of organic matter and crop residues are added in the soil. (Malewar, 1995). The data on $CaCO_3$ indicates that these soils were non-calcareous to calcareous. The $CaCO_3$ in these soils ranged from 1.31 to 7.32 per cent with a mean value of 4.25 per cent. The low to medium $CaCO_3$ content in the soils is might be due to the presence of $CaCO_3$ in different proportions and in powdery form with hyper thermic temperate regime of Nagpur district. Similar findings were reported by Pharande *et al.* (1996).

The data presented in Table 2 depict that the available Zn contents ranged from 0.18 to 0.54 mg kg^{-1} with an average value of 0.33 mg kg^{-1} in sunflower growing soils of Nagpur district. These samples were low to slightly medium in available Zn content. This is might be due to the fact that in well drained, aerated, calcareous soils, zinc exits in oxidized state and their availability becomes very low (Malewar, 1995). Patil and Shingte (1982) also observed the available Zn content of soils in the similar range of 0.15 to 2.00 ppm in Pune region. Some Alfisols from Meghalaya, Inceptisol from Maharashtra, Vertisol and Alfisol in Maharashtra also showed the content of Zn in the similar range (Joplin *et al*., 1993; Malewar, 1995 and Pharande *et al.*, 1996).

The available Fe content in data under study ranged from 10.02 to 22.52 mg kg^{-1} with an average value of 16.10 mg kg^{-1} in Nagpur district. This high Fe content in soil was due to the presence of minerals like feldspar, magnetite, hematite and limonite which together constitute bulk of trap rock in these soils. Pharande *et al.* (1996) also recorded the available Fe in Vertisol of Maharashtra in the similar range from 3.52 to 19.44 mg kg^{-1}. The results are also in accordance with the findings of Gupta *et al.* (2003) and Hundal *et al.* (2006).

The available Mn content in these soils varied from 9.21 to 29.41 mg kg^{-1} with an average value of 18.45 mg kg^{-1}. This high status of Mn might be due to the fact that lower oxidation (reduced) states of Mn were more soluble than higher oxidation state at normal pH range of soils and oxidation of divalent Mn^{++} to trivalent Mn^{+++} by certain fungi and bacteria. Certain organic compounds synthesized by micro-organisms or released by the plants as root exudates. The similar range of available Mn was reported in the soils from Maharashtra (Chavan *et al*., 1980), Orissa (Saha *et al*.,1996), Bihar (Bhogal *et al*.,1993) and Ladakh (Dwivedi *et al*., 2005).

The sunflower growing soils of Nagpur district were

Table 1 : Soil chemical properties of sunflower growing soils of Nagpur district

Soil-chemical properties	Range	Mean
pH	7.93-8.64	8.39
EC (dSm^{-1})	0.19-0.67	0.28
Organic carbon (%)	0.24-0.79	0.51
$CaCO_3$ (%)	1.31-7.32	4.25

Table 2 : DTPA extractable micronutrient contents of the sunflower growing soils of Nagpur district

Available micronutrients	Range (ppm)	Mean (ppm)
Zn	0.18-0.54	0.33
Fe	10.02-22.52	16.10
Mn	9.21-29.41	18.45
Cu	0.76-3.32	1.13

Table 3 : Correlation co-efficient (r values) between chemical properties and available micronutrients

Chemical properties	Zn	Fe	Mn	Cu
pH	-0.125*	-0.83	-0.65	-0.111
EC	0.149**	0.135**	-0.130**	0.101*
O.C.	0.93	0.106*	0.96	0.170**
$CaCO_3$	-0.97*	-0.141*	-0.92	-0.90

* and ** indicate significance of values at P=0.05 and 0.01, respectively

high in Cu content (0.76 to 3.32 mg kg^{-1})with an average value of 1.13 mg kg^{-1}. This Cu content could be attributed to the difference in geology, physiography and degree of weathering in these soils. The similar range of available Cu also observed Patil and Meisheri (2004).

Correlation between chemical properties and available micronutrients :

It is seen from the data (Table 3) that the pH of sunflower growing soils of Nagpur district showed the negative correlation with Zn (-0.125*), Fe (-0.83), Mn (-0.65) and Cu (-0.111) but it was significant in case of available Zinc.The micronutrient availability was decreased with increase in pH of soil. The pH showed negative correlation with Zn, Fe, Mn and Cu also reported by Tiwari and Mishra (1990).

Further data revealed that the organic carbon showed positive correlation with zinc, iron, manganese and copper but it was highly significant with available iron (0.106*) and copper (0.170**).

The availability of micronutrient was increased with increasing organic carbon in soil may be because formation of chelating compounds. These chelates are soluble organic compounds that bound with metals such as Fe, Zn, Cu and Mn increasing their solubility and availability in soil (Tisdale *et al*., 1997).

The data regarding correlation revealed that the $CaCO_3$ were negatively correlated with available Mn (-0.92) and Cu (-0.90) whereas it was negatively significant with available Zn (-0.97*) and iron (-0.141**).

The availability of micronutrients *viz.,* Zn, Fe, Mn and Cu decreased with increase in calcium carbonate content in soil. The decrease in availability of zinc with increasing calcium carbonate in soil may also be attributed to increased soil pH. The decrease in the availability of Cu with increasing pH is because of decreased solubility and increased adsorption of Cu with increase in pH of soil. The availability of Mn (Mn^{2+}) in soil varies with pH. This low Mn availability in soil with increasing level of $CaCO_3$ may also be associate with high soil pH. The high pH of soil also favors the formation of less available organic complexes of Mn (Tisdale *et al.*, 1997).

Among the micronutrients available Zn could becomes a limiting factor, therefore, application of $ZnSO_4$ (25 kg $ZnSO_4$/ha) could help to sustain sunflower yield. Thus, it can be concluded that the chemical properties like pH, organic carbon and $CaCO_3$ contents alone or in combination controls the availability of micronutrients *viz.,* Zn, Fe, Mn and Cu.

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